Quality assurance of MLC using a software for automated quality control and EPID device

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Purpose

Quality assurance of MLC (Mulitileaf Collimator) can be divided into two method. First method the patient specific quality assurance assumed treatment plan verification before every start. Plans are verifying with use for example electronic portal dosimetry. Second one the machine specific quality assurance assumed that MLC parameters like leaf position accuracy for static tests or picket fence test for dynamic tests should be verified every established period of time. Both methods have specific advantages and disadvantages. The aim of this study was to introduce Artiscan software from AQUILAB for automated quality control for MLC machine specific quality assurance.

Methods

The Artiscan software for automated quality control is using mathematical formulas to provide quantitative information about MLC parameters. To improve quality of treatment we have implemented this software. We made proper plans and realized them on our three Clinac 2300CD, one Unique and two TrueBeam, equipped with MLC 120 Millennium and one TrueBeam equipped with MLC HD all from Varian. We analyzed all available parameters for static and dynamic tests. We mainly focused on MLC leaf position static test and all picket fence dynamic tests. Software can be used to compute following parameters: collimator rotation, jaw positioning, MLC perpendicularity, light field – irradiated field relation, bank positioning, field size, leaf position, bank alignment, bank orthogonality and bank sagging, leaf transmissions and leaf penumbra, dMLC dosimetry, dose rate/gantry speed, MLC speed, static and dynamic picket fence tests. Plans have been realized for three months. Almost 3000 DICOM images from linacs were analyzed in Artiscan software.

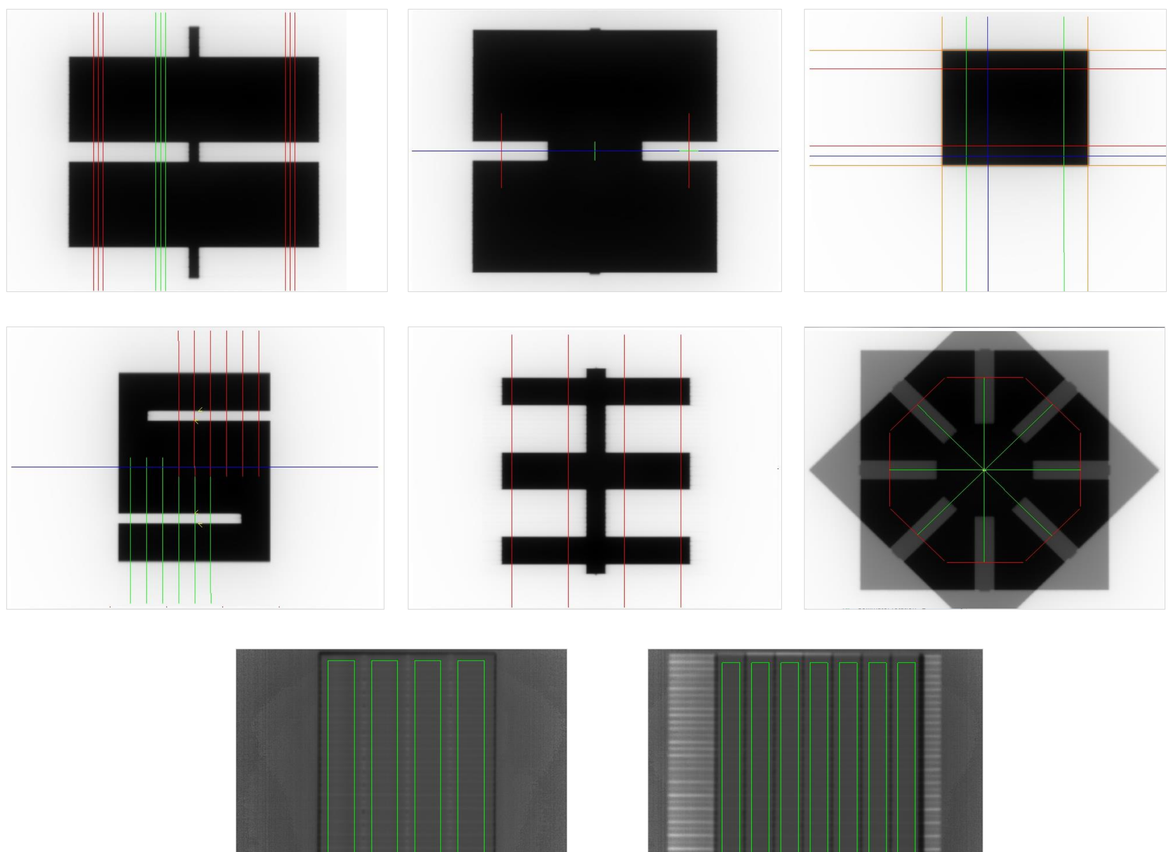

Figure 1. Exemplary obtained images, analyzed by Artiscan software

Results

For four linacs the software for automated quality control showed almost 1.0 mm shifts for leafs positions. We reported that and local service engineer calibrated MLC using standard procedure. After that calibration leaf position shifts decreased to maximum 0.5 mm. No tolerance deviations were observed for the rest of analyzed parameters.

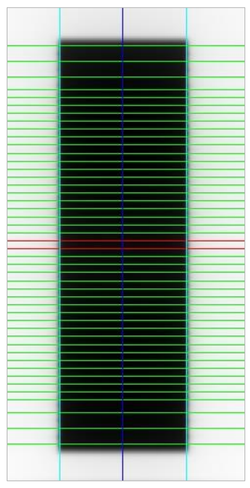

Figure 2. Leaf position is computed by determining the half height distance between reference axis Y and the leaf bank edge at the middle of each leaf. For bank A and bank B position of each leaf is computed. Difference between computed position and prescribed position of each leaf shouldn't be greater than 2 mm.

Table 1. Leaf position error (mm) before the calibration.

Leaf position error (mm)					
Leaf index	Bank X1	Bank X2	Leaf index	Bank X1	Bank X2
8	-0.40	1.03	31	-0.46	1.08
9	-0.37	1.03	32	-0.43	1.19
10	-0.46	1.01	33	-0.60	1.03
11	-0.44	1.09	34	-0.43	1.22
12	-0.50	1.09	35	-0.68	0.93
13	-0.48	1.14	36	-0.60	1.09
14	-0.48	1.11	37	-0.52	1.12
15	-0.43	1.11	38	-0.57	1.02
16	-0.54	1.08	39	-0.53	0.99
17	-0.52	1.09	40	-0.55	1.06
18	-0.54	1.05	41	-0.51	1.08
19	-0.48	1.05	42	-0.48	1.07
20	-0.52	1.09	43	-0.54	1.00
21	-0.56	1.05	44	-0.53	1.06
22	-0.56	1.06	45	-0.54	0.98
23	-0.53	1.10	46	-0.54	0.97
24	-0.57	1.06	47	-0.58	0.87
25	-0.58	1.06	48	-0.57	0.92
26	-0.54	1.04	49	-0.56	0.90
27	-0.59	1.01	50	-0.44	1.01
28	-0.61	1.03	51	-0.49	0.86
29	-0.56	1.07	52	-0.54	0.82
30	-0.55	1.09	53	-0.49	0.76

Table 2. Leaf position error (mm) after the calibration.

Leaf position error (mm)					
Leaf index	Bank X1	Bank X2	Leaf index	Bank X1	Bank X2
8	-0.58	0.68	31	-0.57	0.79
9	-0.53	0.70	32	-0.67	0.83
10	-0.57	0.66	33	-0.71	0.77
11	-0.56	0.73	34	-0.63	0.86
12	-0.54	0.74	35	-0.69	0.83
13	-0.61	0.74	36	-0.75	0.79
14	-0.49	0.78	37	-0.60	0.84
15	-0.61	0.70	38	-0.64	0.79
16	-0.62	0.78	39	-0.65	0.74
17	-0.61	0.74	40	-0.63	0.87
18	-0.54	0.74	41	-0.59	0.83
19	-0.62	0.70	42	-0.52	0.85
20	-0.58	0.77	43	-0.60	0.76
21	-0.67	0.73	44	-0.60	0.86
22	-0.55	0.75	45	-0.66	0.86
23	-0.70	0.78	46	-0.61	0.77
24	-0.64	0.77	47	-0.59	0.69
25	-0.68	0.76	48	-0.60	0.77
26	-0.58	0.80	49	-0.62	0.77
27	-0.65	0.78	50	-0.57	0.79
28	-0.66	0.77	51	-0.54	0.68
29	-0.61	0.86	52	-0.61	0.64
30	-0.65	0.87	53	-0.55	0.61

Conclusions

Both methods are complimentary but machine specific quality assurance approach can detect smaller difference and can improve accuracy of treatment. For patient specific quality assurance using electronic portal and gamma analysis we routinely use criteria 3% dose difference and 3 mm distance to agreement. These criteria will not detect such small differences in MLC working like 1mm. However we still need more measurements to observe variability of parameters to adopt tolerance and to create levels of respond.

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